Claims

We claim:

1. A sheet guiding apparatus for guiding and decelerating a sheet of web material as the sheet is fed into a starwheel from upstream sheet feeding equipment, the starwheel having slots and being rotatable to receive and discharge the sheet; the sheet guiding apparatus comprising:

a conveyor belt located adjacent the starwheel, the conveyor belt rotatable at a speed less than that of the upstream sheet feeding equipment; and

a conveying surface defined at least partially by the conveyor belt, the conveying surface positioned to contact, guide, and decelerate a trailing edge of the sheet as the sheet enters the starwheel.

2. The apparatus as claimed in claim 1, wherein the starwheel has a center and an outer radius, and wherein at least a portion of the conveyor belt is located at a radial position less than the outer radius of the starwheel with respect to the center of the starwheel.

3. The apparatus as claimed in claim 1, wherein the conveyor belt is one of a plurality of conveyor belts.

4. The apparatus as claimed in claim 2, wherein the plurality of conveyor belts is arranged end-to-end.

5. The apparatus as claimed in claim 4, wherein the conveying surface is defined by the plurality of conveyor belts arranged end-to-end, and is concave with respect to the starwheel.

6. The apparatus as claimed in claim 2, wherein the plurality of conveyor belts is arranged side-by-side.

7. The apparatus as claimed in claim 1, wherein the conveying surface is adjustable to different positions with respect to the starwheel, the conveying surface being adjustable

toward and away from the starwheel to increase and decrease contact between the conveying surface and the sheet.

8. The apparatus as claimed in claim 1, wherein the starwheel has a periphery, and wherein a point on the conveyor belt moves at substantially the same velocity as that of a point on the periphery of the starwheel.

9. The apparatus as claimed in claim 1, wherein the starwheel has a periphery, and wherein a point on the conveyor belt moves at a velocity greater than that of a point on the periphery of the starwheel.

10. The apparatus as claimed in claim 1, wherein the starwheel has a periphery, wherein a point on the conveyor belt moves at a first velocity and a point on the periphery of the starwheel moves at a second velocity, and wherein the ratio of the first velocity to the second velocity is at least 1.2:1.

11. The apparatus as claimed in claim 1, wherein the starwheel has a periphery, wherein a point on the conveyor belt moves at a first velocity and a point on the periphery of the starwheel moves at a second velocity, and wherein the ratio of the first velocity to the second velocity is approximately 1.43:1.

12. The apparatus as claimed in claim 1, wherein the starwheel has a periphery, wherein a point on the conveyor belt moves at a first velocity and a point on the periphery of the starwheel moves at a second velocity, and wherein the ratio of the first velocity to the second velocity is less than 4:1.

13. The apparatus as claimed in claim 1, wherein the starwheel has a periphery, wherein a point on the conveyor belt moves at a first velocity and a point on the periphery of the starwheel moves at a second velocity, and wherein the ratio of the first velocity to the second velocity is approximately 3.2:1.

14. The apparatus as claimed in claim 1, wherein the upstream sheet feeding equipment moves the sheet at a first velocity and the conveyor belt moves at a second velocity, and wherein the ratio of the first velocity to the second velocity is at least 1:1.

15. The apparatus as claimed in claim 1, wherein the upstream sheet feeding equipment moves the sheet at a first velocity and the conveyor belt moves at a second velocity, and wherein the ratio of the first velocity to the second velocity is between 1:1 and 4:1.

16. The apparatus as claimed in claim 1, wherein the upstream sheet feeding equipment moves the sheet at a first velocity and the conveyor belt moves at a second velocity, and wherein the ratio of the first velocity to the second velocity is between 1:1 and 3:1.

17. The apparatus as claimed in claim 1, wherein the upstream sheet feeding equipment moves the sheet at a first velocity and the conveyor belt moves at a second velocity, and wherein the ratio of the first velocity to the second velocity is approximately 1.75:1.

18. The apparatus as claimed in claim 1, wherein the upstream sheet feeding equipment moves the sheet at a first velocity and the conveyor belt moves at a second velocity, and wherein the ratio of the first velocity to the second velocity approximately 2.27:1.

19. The apparatus as claimed in claim 1, wherein the conveyor belt is drivably connected to the upstream sheet feeding equipment.

20. The apparatus as claimed in claim 1, wherein the conveyor belt is drivably connected to the upstream sheet feeding equipment through a speed reduction.

21. A method of feeding sheets of a web material into a starwheel using a starwheel feed apparatus, the starwheel having at least one slot and the starwheel feed apparatus having at least one conveyor belt adjacent the starwheel; the method comprising:

moving a sheet to the at least one conveyor belt;

advancing the sheet along the at least one conveyor belt;

feeding the sheet into one of the at least one slot of the starwheel;

decelerating the sheet with the at least one conveyor belt as the sheet enters the starwheel;

rotating the starwheel.

22. The method as claimed in claim 21, further comprising contacting the sheet and guiding the sheet into the at least one slot with the at least one conveyor belt.

23. The method as claimed in claim 21, wherein decelerating the sheet is accomplished by operating the conveyor belt at a speed less than that of upstream sheet feeding equipment.

24. The method as claimed in claim 21, further comprising:

moving the sheet adjacent at least one barrier;

ejecting the sheet from the at least one slot; and

stacking the sheet upon at least one other sheet.

25. The method as claimed in claim 21, wherein the conveyor belt has a conveying surface and the conveying surface has a length, and further comprising guiding a trailing edge of the sheet along the length of the conveying surface into the at least one slot.

26. The method as claimed in claim 21, wherein moving a sheet to the at least one conveyor belt includes moving the sheet at a first velocity, and wherein advancing the sheet along the at least one conveyor belt includes advancing the conveyor belt at a second velocity.

27. The method as claimed in claim 26, wherein the first velocity is greater than the second velocity.

28. The method as claimed in claim 27, wherein the ratio of the first velocity to the second velocity is approximately 1.75:1.

29. The method as claimed in claim 27, wherein the ratio of the first velocity to the second velocity is approximately 2.27:1.

30. The method as claimed in claim 21, wherein advancing the sheet along the at least one conveyor belt includes advancing the sheet at a first velocity, and wherein rotating the starwheel includes moving a periphery of the starwheel at a second velocity different than the first velocity.

31. The method as claimed in claim 30, wherein the first velocity is at least 1.2 times the second velocity.

32. The method as claimed in claim 30, wherein the ratio of the first velocity to the second velocity is approximately 1.43:1.

33. The method as claimed in claim 30, wherein the first velocity is less than four times the second velocity.

34. The method as claimed in claim 30, wherein the ratio of the first velocity to the second velocity is approximately 3.2:1.

35. The method as claimed in claim 21, wherein decelerating the sheet occurs by operating the conveyor belt in a direction opposite that of upstream sheet feeding equipment.

36. A starwheel feed apparatus for feeding sheets of web material into a starwheel, the starwheel having slots and being rotatable to receive the sheets in a first position and discharge the sheets in a second position, the slots positioned to receive and carry the sheets as the starwheel rotates, each sheet having a leading edge and a trailing edge; the starwheel feed apparatus comprising:

a feeding conveyor located upstream of the starwheel and movable to convey sheets at a velocity toward the starwheel;

a guiding conveyor located adjacent the starwheel, the guiding conveyor having a conveying surface movable to convey sheets at a velocity less than sheets conveyed by the feeding conveyor;

the conveying surface having a length and oriented to contact and guide the trailing edges of the sheets along the length of the conveying surface as the sheets enter the slots.

37. The apparatus as claimed in claim 36, wherein the feeding conveyor travels at a first velocity and the guiding conveyor travels at a second velocity.

38. The apparatus as claimed in claim 37, wherein the ratio of the first velocity to the second velocity is between 1:1 and 4:1.

39. The apparatus as claimed in claim 37, wherein the ratio of the first velocity to the second velocity is between 1:1 and 3:1.

40. The apparatus as claimed in claim 37, wherein the ratio of the first velocity to the second velocity is approximately 1.75:1.

41. The apparatus as claimed in claim 37, wherein the ratio of the first velocity to the second velocity is approximately 2.27:1.

42. The apparatus as claimed in claim 36, wherein the starwheel is one of a plurality of starwheels, and wherein at least one of the feeding conveyor and the guiding conveyor are located at least partially between starwheels.

43. The apparatus as claimed in claim 36, wherein the feeding conveyor is one of a set of feeding conveyors between which the sheet is moved toward the starwheel.

44. The apparatus as claimed in claim 36, wherein the guiding conveyor is one of a plurality of guiding conveyors.

45. The apparatus as claimed in claim 44, wherein the plurality of guiding conveyors is arranged end-to-end.

46. The apparatus as claimed in claim 45, wherein the conveying surface is defined by the plurality of guiding conveyors arranged end-to-end, and is concave with respect to the starwheel.

47. The apparatus as claimed in claim 44, wherein the plurality of guiding conveyors is arranged side-by-side.

48. The apparatus as claimed in claim 36, wherein the guiding conveyor travels at a first velocity and a tangential velocity of the starwheel is a second velocity different than the first velocity.

49. The apparatus as claimed in claim 48, wherein the first velocity is greater than the second velocity.

50. The apparatus as claimed in claim 48, wherein the first velocity is at least 1.2 times the second velocity.

51. The apparatus as claimed in claim 48, wherein the ratio of the first velocity to the second velocity is approximately 1.43:1.

52. The apparatus as claimed in claim 48, wherein the first velocity is greater than the second velocity and is less than four times the second velocity.

53. The apparatus as claimed in claim 48, wherein the ratio of the first velocity to the second velocity is approximately 3.2:1.

54. The apparatus as claimed in claim 36, wherein the guiding conveyor is a conveyor belt.

55. The apparatus as claimed in claim 36, wherein the conveying surface is concave with respect to the starwheel.

56. The apparatus as claimed in claim 36, wherein the conveying surface is substantially tangential to the starwheel.

57. The apparatus as claimed in claim 36, wherein the guiding conveyor is drivably connected to the feeding conveyor.

58. The apparatus as claimed in claim 36, wherein the guiding conveyor is drivably connected to the feeding conveyor through a speed reduction.

59. The apparatus as claimed in claim 36, further comprising a barrier positioned to contact the sheet and cause the sheet to be discharged from the starwheel.

60. A method of guiding a sheet of web material into a starwheel, the sheet having a leading edge and a trailing edge; the method comprising:

moving the sheet toward the starwheel along a feeding conveyor having a first velocity;

feeding the sheet into a slot in the starwheel;

moving the sheet in the slot toward an inserted position;

contacting the sheet with a conveying surface as the sheet moves in the slot, the conveying surface having a velocity less than the first velocity;

decelerating the sheet with the conveying surface;

rotating the starwheel; and

guiding the trailing edge of the sheet along a length of the conveying surface as the sheet enters the slot.

61. The method as claimed in claim 60, further comprising conveying the sheet with the conveying surface at a second velocity, and wherein the ratio of the first velocity to the second velocity is between 1:1 and 4:1.

62. The method as claimed in claim 60, further comprising conveying the sheet with the conveying surface at a second velocity, and wherein the ratio of the first velocity to the second velocity is between 1.5:1 and 2.5:1.

63. The method as claimed in claim 60, further comprising conveying the sheet with the conveying surface at a second velocity, and wherein the ratio of the first velocity to the second velocity is approximately 1.75:1.

64. The method as claimed in claim 60, further comprising conveying the sheet with the conveying surface at a second velocity, and wherein the ratio of the first velocity to the second velocity is approximately 2.27:1.

65. The method as claimed in claim 60, further comprising conveying the sheet with the conveying surface at a second velocity, and wherein rotating the starwheel includes moving the sheet in the starwheel at a third velocity measured as a tangential speed of the starwheel.

66. The method as claimed in claim 65, wherein the second velocity is greater than the third velocity.

67. The method as claimed in claim 65, wherein the second velocity is at least 1.2 times the third velocity.

68. The method as claimed in claim 65, wherein the ratio of the second velocity to the third velocity is approximately 1.43:1.

69. The method as claimed in claim 65, wherein the second velocity is greater than the third velocity and is less than four times the third velocity.

70. The method as claimed in claim 65, wherein the ratio of the second velocity to the third velocity is approximately 3.2:1.

71. The method as claimed in claim 60, wherein contacting the sheet includes contacting the sheet with a conveying surface of a conveyor belt.

72. The method as claimed in claim 60, wherein guiding the trailing edge of the sheet includes guiding the trailing edge of the sheet along a length of a plurality of conveying surfaces.